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The vertebrate fossil collection record from the Chinchilla Sand, South-East Queensland, 1844–2021

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ABSTRACT

Since the mid-1840s a diverse fossil vertebrate assemblage, referred to as the Chinchilla Local Fauna, has been collected from the Pliocene deposits of the Chinchilla Sand on the western Darling Downs of South-East Queensland. In large part because of this long history and the numerous collectors who have worked fossil deposits in the area, much ambiguity regarding site and locality names and their specific coordinates exists. Here, we review the vertebrate fossil collection records in the Queensland Museum Fossil, Donor, Collector and Locality Registers, correspondence, and field notes in an effort to pinpoint the location of each named locality and site and develop a digital map which highlights the historical collecting sites at one significant locality in the Chinchilla area. To ensure that a systematic framework for all future collecting from the main collecting area (Chinchilla Rifle Range) is maintained, we recommend the use of consistent nomenclature for sites so that spatial information of the highest possible quality is captured into the future. We recommend future collections include detailed recordings of stratigraphic contexts as well as GPS coordinates.

❑ *Chinchilla Sand, Chinchilla Local Fauna, Pliocene, geoheritage, Australia, Darling Downs*

The Darling Downs is a fertile agricultural region in South-East Queensland extending west of Brisbane from the Great Dividing Range to the Condamine River and its catchments. The earliest-known Indigenous occupation of the region dates to the late Pleistocene (Gill 1978). European settlers began to select land in the region from the early 1840s, seeing the potential for agricultural development, and early correspondence, diaries and newspaper articles report frequent fossil discoveries. Explorer, naturalist and keen fossil collector, Ludwig Leichhardt, mentions fossil collections from the Darling Downs in a letter to Sir Richard Owen, on 10 July 1844, "*the collection of fossil bones I made in Darling Downs...*' (Leichhardt 1844). In 1875 an article in a Brisbane newspaper, reporting on recent additions to the Queensland Museum collection, mentions, "*Some excellent fossils have also been received, prominent among which are part of the upper jaw of the extinct Diprotodon*" (Anon 1875). Many of these fossils made their way to Brisbane or Sydney for identification, but with limited local expertise they were subsequently sent to experts in England, such as anatomist and palaeontologist Sir Richard Owen, for identification and study.

The latter half of the 1800s was a time of great expansion in scientific knowledge all over the Commonwealth, with collection and donation of specimens to fledgling museums

by the public becoming commonplace. In 1862, the Queensland Museum was established and palaeontologist Charles de Vis committed himself to developing a thorough understanding of the Darling Downs fossils. Early Museum palaeontologists and collectors began to differentiate between the collections from the eastern Darling Downs, being exclusively Pleistocene, and those from the western Darling Downs including Chinchilla (Mackness and Godthelp 2001; Price 2012). Thus began the collection history of fossils from the Chinchilla area, which continues to the present day.

Localities with long collection histories often present curatorial challenges where documentation is vague, incomplete, or even incorrect, which can lead to confusion for museum staff and researchers. Many Chinchilla fossils collected in the 19th Century lacked clear collection data, and on some occasions, material collected from surrounding areas, packed and transported to Brisbane from Chinchilla, was labelled 'Chinchilla', adding to the confusion (Mackness & Godthelp 2001). Similar challenges were experienced at other museums such as the early records of fossil collections from Wellington Caves at the Australian Museum (Dawson 1985). While consistency is certainly the aim, changes in museum staff over time, changes in collection and curatorial practice and a variation in the approaches used in the documentation of sites can lead to inconsistencies in recording important information, resulting in the loss of both site-specific and fossil-specific details. Invariably the quality of data available has improved over time with access to geo-reference information from printed and digital sources and modern technologies.

Here we examine 150 years of vertebrate fossil collection history from the Chinchilla Sand, a geological formation that has yielded Australia's largest, richest, and best-preserved vertebrate Pliocene assemblage (Cook 2012). This assemblage is referred to as the Chinchilla Local Fauna and is represented by at least 63 fossil taxa in 31 families (Louys & Price 2015). A significant proportion of the Pliocene vertebrate fossils (hereafter fossils) currently housed in the Queensland Museum Geosciences Collection are from this formation and in particular a locality known as the Chinchilla Rifle Range. Our aim is to develop a clear understanding of locality and site names in the Chinchilla Sand and explore the possibility of establishing provenance of historically collected material with confidence. This project, a joint collaboration between the Queensland Museum, the Samford Valley Steiner School, Griffith University and the University of Queensland, aimed to establish a detailed digital map highlighting key sites and landmarks of the main gully system at the Chinchilla Rifle Range, referred to as 'Middle Gully system' (Bartholomai, 1966). The map brings together all known sites in the vicinity of Middle Gully system into a digital format. The integration of historical and cartographical data will help ensure more accurate collecting and documentation of the site into the future.

HISTORICAL AND GEOGRAPHICAL CONTEXT

The Chinchilla Sand is located on the western Darling Downs in the Condamine River system of South-East Queensland (Fig. 1), and lies on the traditional lands of the Burunggum people. In January 1846 European settler Matthew Buscall Goggs was the first to apply for a depasturing license on the lower Condamine. His lease included the current Chinchilla township, Branch Creek to the north, parts of Charleys Creek, a portion of the Condamine River and the land where the Chinchilla Rifle Range is situated today (Truscott 2004). Goggs' property remained unnamed until 1847 when it was called 'Lower Condamine', then in 1848 it was renamed 'Chinchilla Station' (Mathews 2004). The Chinchilla Post Office opened on 3 January 1878 and with this came the birth of the township of Chinchilla. It is worth noting that for a period of 30 years, between 1848 and 1878, fossils with associated locality data using the word 'Chinchilla' would have referred to 'Chinchilla Station', and not necessarily to the township of Chinchilla.

The Chinchilla Sand is a formally defined Pliocene sequence that consists of inter-bedded fluvial and alluvial clays, sands, and

conglomerates (Woods 1960), many of which contain abundant fossils with an estimated age inferred by faunal correlation of 3.6 Ma (Louys & Price 2015). Fossil bearing Quaternary sediments, probably Pleistocene in age, surround the Chinchilla Sand in all directions and a small amount overlies the northern part of the sequence near the Chinchilla township (Fig. 1A). A small number of fossil specimens collected in likely Quaternary deposits to the north and north-west of the mapped Chinchilla Sand at 'Fairymeadow', Charleys Creek, 'Seven Oaks' and 'Tralee' appeared in our search but without stratigraphic context we cannot verify these as Pliocene.

Within the Chinchilla Sand one important locality, known as the Chinchilla Rifle Range, deserves attention for its abundance of fossils and continuous collection history. The Chinchilla Rifle Range, a highly significant geoheritage site (Percival 2014; Australian Heritage Council 2012), lies within the Chinchilla Sand Local Fossil Fauna Site, defined in the Australian Heritage Database Register of National Estate (non-statutory archive) (Anon 2020) as approximately 120 hectares of State-owned land, 3 kms south-east of Chinchilla, extending from the Warrego Highway to the Condamine River (Fig. 1). This locality is the last remaining example of the Chinchilla Sand with an intact profile and includes the type section described by Jack Woods (Woods 1960) on the banks of the Condamine River (Fig. 2).

Not only recognised as an important palaeontological site, this locality is also recognised for its geological, botanical, zoological, cultural, and historical importance. The native vegetation is one of the few remaining sizeable examples of original Brigalow vegetation (open forest dominated by the brigalow tree, *Acacia harpophylla*) associated with the Condamine River, and in 2002, the land was declared a 'Nature Refuge' under the Nature Conservation (Protected Areas) Regulation 1994. A rifle range was established on the land in 1912, and as part of the Nature Conservation Agreement a lease agreement was established with the Sporting Shooters Association of Australia (SSAA), Chinchilla Branch. Access to the locality is therefore strictly regulated by the SSAA for safety reasons and the SSAA will only consider requests to undertake research on the sites from recognised scientific institutions, or those working under their auspices.

MATERIALS AND METHODS

Queensland Museum records and data collaboration

Queensland Museum records used in our review include Donor Registers No.1 (1875-1881), Donor Register No. 2 (1882-1887), Donor Register No.3 (1899-1909), Donor Register No. 4 (1899-1909), Donor Register No. 5 (1910), Extended Donor Register (1885 – 1888), Extended Donor Register (1887-1910), QM 'Old' Collection Register C1-C178 (1884-1899), QM Donors Schedule (1911-1946), QM Library Inward Correspondence Registration records, QM Library archives (Kendall Broadbent field diaries 1886-1889), Cecil (hereafter Cec) and Doris Wilkinson's collection records (hereafter Wilkinson Collection Register) and the QM Collection Management System (hereafter QM CMS) which includes digital records of the QM Fossil Register (hereafter QMF), and the QM Locality Register (hereafter QML) which are still actively in use.

Newspaper records accessed via online research portal, TROVE, were also utilised and clarification of some data was established via personal communications with key collectors, researchers, and donors. These included Jack Woods (QM Director 1964-1968), Alan Bartholomai (QM Curator, Director 1969-1999), Michael Archer (QM Curator 1972-1978), Henk Godthelp (QM Palaeontologist 1976-1979, 1981-1982), Ralph Molnar (QM Curator 1978-2000) and local Chinchilla fossil collectors and QM Honorary Officers, Cec and Doris Wilkinson.

The fossil collection history presented in Table 1 is divided into 6 collection phases and includes a complete list of collectors, data source, and a data accuracy rating with an increase in accuracy over time clearly discernable. Low levels of

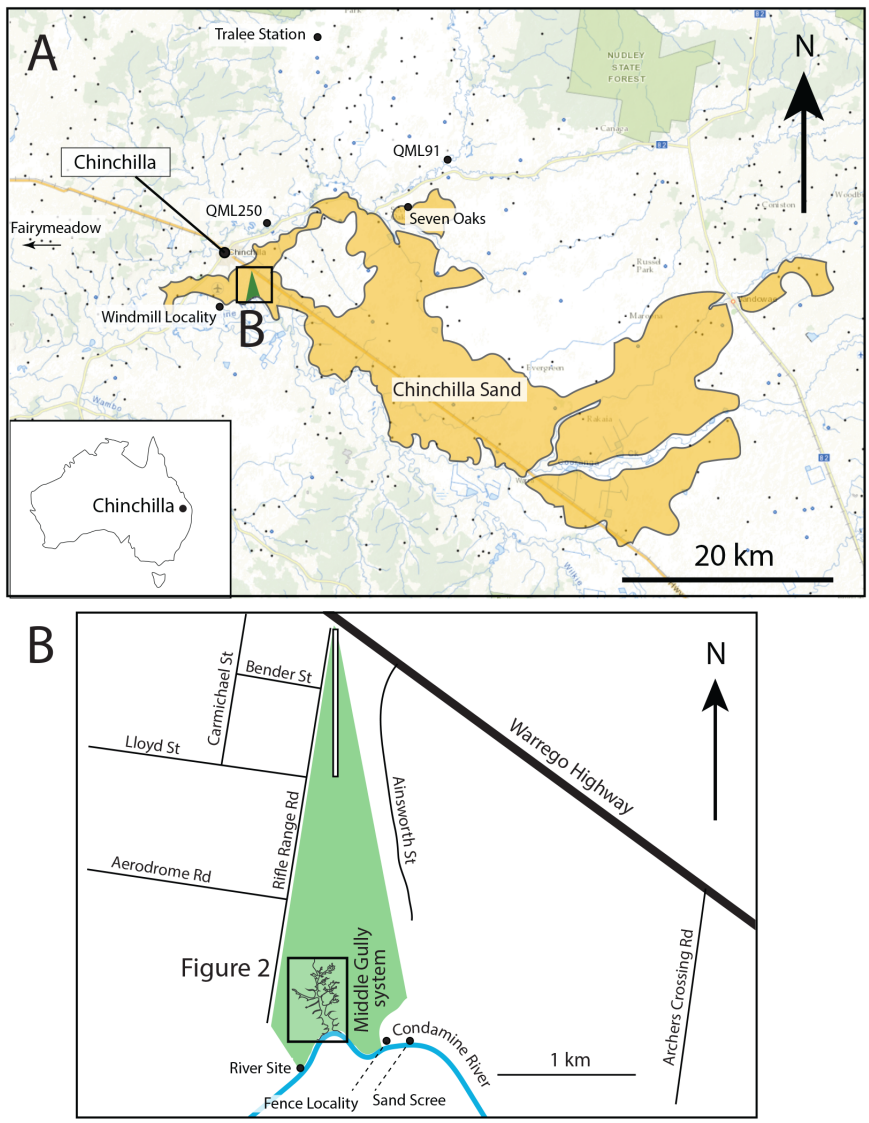

FIG. 1. Study region. A, Location of Chinchilla on the western Darling Downs, the Chinchilla Sand, the Chinchilla Sand Local Fossil Fauna Site (including Chinchilla Rifle Range) and vertebrate fossil localities mentioned in the text; B, Map showing Chinchilla Sand Local Fossil Fauna site (including Chinchilla Rifle Range), location of Middle Gully system and vertebrate fossil localities.

data accuracy include general descriptions of local features or township names which rarely allow for relocation of the original collection sites. Medium accuracy data includes map co-ordinates and specific descriptions of local features, such as the rivers and creeks, or descriptions of specific gullies and ridges which may make relocation possible in certain circumstances. High accuracy includes map references and digital technology records, such as GPS (Global Positioning System), leading to confident relocation of original

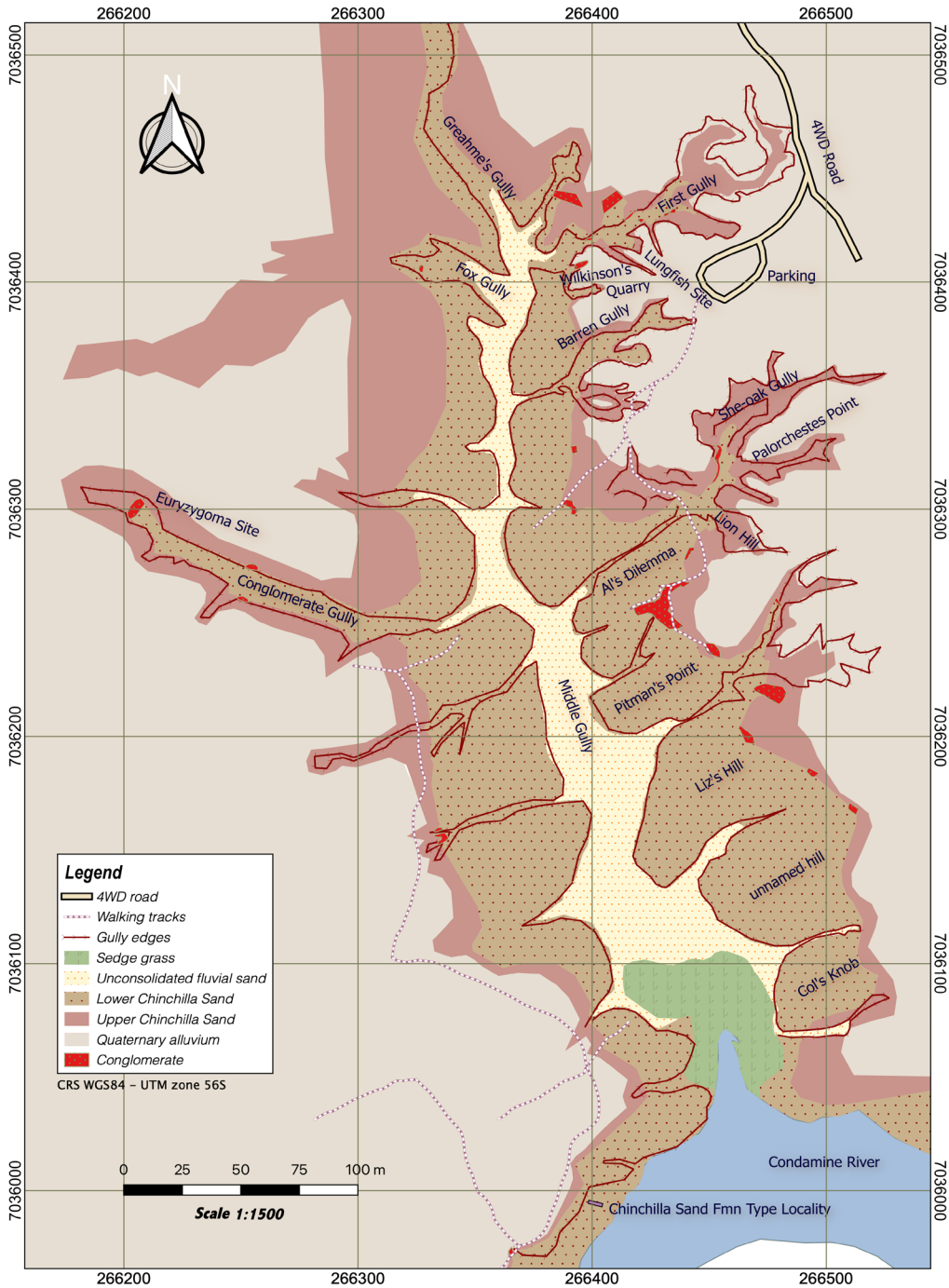

FIG. 2. Digital map of Chinchilla Rifle Range site showing Middle Gully system and site names.

TABLE 1. Collection phases 1-6. *QM Staff; Abbreviations: QM CMS-Queensland Museum Central Management System (Vernon); Low – township or area name and description of local features; Medium - map references; High - GPS data.

Collector	Data Source	Accuracy
Phase 1 1875-1914		
Mr Juric	QM Donor Register 1875-1881. Entry date; 4 May, 1878	Low
Peter Clark	QM Donor Register 1882-1887. Entry date; March 1883, No.506	Low
*Kendall Broadbent	QM CMS; QM Donor Register 1882-1887 Donor Number 4205; QM Collection Register 1884-1899, Collection Numbers 14, 21, 69, 106, 107, 133, 139, 151, and 171; QM Library Inward Correspondence Registration Numbers 281, 334, 508, 509, 526, 527, 537, 560, 2015, 2036, 2055 and 2080. Field diaries 1886-1889 in QM Libaray Archives.	Medium
*Henry Hurst	CMS; QM Library Inward Correspondence Registration Numbers 2242, 2254, 2266 and 2298	Low
*Alexander MacPherson	QM CMS; QM Library Inward Correspondence Registration Numbers 280 and 379	Low
*Henry Tryon	QM Library Inward Correspondence Registratiion Number 315	Low
*Patrick Wall	QM Library Inward Correspondence Registration Number 2242. (Wall is mentioned in correspondence from Hurst to deVis)	Low
Leslie Corrie	QM Donors Schedule. Entry Date; 4 May, 1912	Low
Benjamin Dunstan	QM CMS	Low
Phase 2 1915-1950		
C. Bishop	QM CMS	Low
A. Bishop	QM CMS	Low
G. Kleidon	QM CMS	Medium
Phase 3 1951 - 1970		
M. McEnna	QM CMS	Low
Stirton,Marcus & Woodward expedition	QM CMS	Low
*Jack Woods	QM CMS	Medium
*Alan Bartholomai	QM CMS	Medium
W. Dunmall	QM CMS	Low
R. Olsen	QM CMS	Low
K. Kerr	QM CMS	Low
Malcom and Marjorie Wilson	QM CMS	Low
F. Nothdraft	QM CMS	Medium
R. Lowardon	QM CMS	Low
K. Emmerson	QM CMS	Medium
M. Schuster	QM CMS	Low
Phase 4 1971-1980		
*Alan Bartholomai	QM CMS	Medium

TABLE 1 cont…

Collector	Data Source	Accuracy
*Michael Archer	QM CMS, M. Archer field notes, 1973-1974	Medium
*Jeanette Covacovich	QM CMS, M. Archer field notes, 1973-1974	Medium
Hendrick (Henk) Godthelp	QM CMS	Medium
Malcolm & Marjorie Wilson	QM CMS	Medium
*Roland Mackay	QM CMS	Medium
Kelvin Grove Teachers College	QM CMS, M. Archer field notes, 1973-1974	Medium
Bernard Cooke	QM CMS, M. Archer field notes, 1973-1974	Medium
P. Pitman	QM CMS, M. Archer field notes, 1973-1974	Medium
Col Limpus	QM CMS, M. Archer field notes, 1973-1974	Medium
D. Archibald	QM CMS	Low
D. Worthington	QM CMS	Medium
Phase 5 1981 - 2000		
*Alan Bartholomai	QM CMS	Medium
Joan Wiffen	QM CMS	Medium
D. Worthington	QM CMS	Medium
E. Yansen & party	QM CMS	Medium
*Tempe Lees	QM CMS	Medium
C & D Wilkinson	QM CMS	High
*Laurie Beirne	QM CMS	High
Chris Cameron	QM CMS	Medium
Mrs Bennett	QM CMS	Low
*Ralph Molnar	QM CMS	High
*Paul Stumkat	QM CMS	High
*Joanne Wilkinson	QM CMS	High
Brian Mackness	QM CMS	High
Mrs Austin	QM CMS	High
M. Wilkinson	QM CMS	High
Malcolm & Marjorie Wilson	QM CMS	Medium
Jewel Pozefsky	QM CMS	Low
John Eustice	QM CMS	Low
Paul McKenzie	QM CMS	Medium
Robert Knezour	QM CMS	High
*Scott Hocknull	QM CMS	High

TABLE 1 cont…

Collector	Data Source	Accuracy
Phase 6 2000-2020		
C. & D. Wilkinson	QM CMS	High
A. Bishop	QM CMS	Low
John Eustice	QM CMS	High
Malcolm and Marjorie Wilson	QM CMS	Medium
Ian Sobbe	QM Reserve Collection	High
Geoff and Dorothy Vincent	QM CMS, QM Reserve Collection	Low
Gilbert Price	QM Reserve Collection	High
Julien Louys	QM CMS, QM Reserve Collection	High
Kenny Travouillon	QM Reserve Collection	High
*Mary Wade	QM Reserve Collection	High
*Peter Jell	QM Reserve Collection	High
*Alex Cook	QM Reserve Collection	High
*Andrew Rozefelds	QM Reserve Collection	High
*Scott Hocknull	QM CMS, QM Reserve Collection	High
*Kristen Spring	QM Reserve Collection	High
*Joanne Wilkinson	QM CMS, QM Reserve Collectin	High
*Rochelle Lawrence	QM Reserve Collection	High
*Christina Chiotakis	QM Reserve Collection	High

collection sites. Fossil material collected by QM staff in Phase 6 is incorporated into either the QM Reserve Collections or registered as part of the QM State Research Collection.

A complete list of site and locality names from the Chinchilla Sand was compiled using the QM CMS based on locality, collection, and acquisition field parameters, as well as existing field notes, diaries, correspondence, publications, and the Wilkinson Collection Register. This list is presented in Table 2 and while these sites and locality names were not commonly cited in research publications, they are useful when collating data coupled with field maps and field notes. It should be noted that there are two different, but equally correct, ways in which numbers may be allocated in the QML system. An individual number may represent a site/locality, or alternatively, may represent a single collecting event, depending on which is more appropriate for the fieldwork project. Collection trips to Chinchilla Rifle Range between 1964 and 1982 with allocated numbers QML7, QML237, QML238, QML239, QML242, QML243, QML247, QML248, QML249, QML298, QML299, QML300, QML303, QML304, QML308, QMF357, QML437 and QML438 relate to single collection events and do not represent a site-specific location, so they do not appear on figures 1 or 2.

A literature search identified two published sites from the Chinchilla Rifle Range, 'Middle Gully system', first published by Alan Bartholomai (Bartholomai 1966), and 'Wilkinson's Quarry', first published by Brian Mackness *et al.* (2000). Some sites are known

by more than one name and these appear as synonyms in Table 2, with published names or names appearing in acknowledged registers or field notes taking precedence.

The ability to link early sites and localities to collectors strengthens the ability to pinpoint where specimens were collected prior to the use of modern methods, such as GPS and photogrammetry. Cec and Doris Wilkinson provided a detailed locality map linking many of the site names to the Wilkinson Collection Register, and in 2014 accompanied two of the authors to the Chinchilla Rifle Range to undertake a GPS survey where each site was located, carefully examined, and recorded. The final step was to establish a map of the Middle Gully system, incorporating this data.

Map production and interpretation. A series of four annual surveying camps, from 2014–2017, involving students and staff from several Steiner schools, collected data to produce a digital map of Middle Gully system at the Chinchilla Rifle Range (Fig. 2). A triangulation grid of approximately 4000 m^2 was laid out over four overlapping sections of the map area with all angles measured at each grid point. A 'baseline' measurement was chosen from a single side in the triangulation grid and used to calculate all grid side lengths with the sine rule and the previously measured grid angles. The Universal Transverse Mercator (UTM) Coordinate Reference System (CRS) was used for both surveying and mapping. The UTM location of the grid point at each end of the baseline was determined using GPS averaging using a Garmin GPSmap62S. Some basic surface geology including outcrops of conglomerate, alluvial sand, and changes in sediments higher up in gully profiles were noted by the surveying students. The map legend includes unconsolidated fluvial sand, lower Chinchilla Sand, upper Chinchilla Sand, Quaternary alluvium, and conglomerate. The authors acknowledge that the terms "lower Chinchilla Sand" and "upper Chinchilla Sand" are not officially recognised geological terms but represent observed changes in sediments, and that further stratigraphic studies are required. The mapping and geographic information system software QGIS (https://qgis.org/en/site/) was used to prepare the map of the Chinchilla Rifle Range site showing Middle Gully system.

RESULTS

Collection History

Phase 1: 1844-1914 Early Collectors. Evidence of fossil collection from the general Darling Downs region, prior to the establishment of the Queensland Museum in 1862, can be found in diaries, correspondence, and newspaper articles. Explorer, naturalist and keen fossil collector Ludwig Leichhardt writes in his diary on 9 April 1844, *"I began my journey over the Downs with the object of visiting those places in which fossil bones had been found."* (Leichhardt 1844). Even though it is clear that Leichhardt collected fossils from the Darling Downs (Fensham & Price 2013), there is no evidence that those specimens were ever accessioned into the collections of the QM. His correspondence to Owen (Leichhardt 1844) suggests his collections were sent to Richard Owen, in England, for identification. The first fossil record from Chinchilla appears in the QM Donor Register (1882-1887) on 4 May 1878, donated by Mr Juric. The entry simply states 'fossil bones from Chinchilla' with no other details and unfortunately was typical of many such donations at the time. In 1882 Charles de Vis began his career as Curator (1882-1901) and later Director (1901-1905) at QM and arranged employment of collectors, clerical assistants, and assistant curators including Kendall Broadbent, Henry Hurst, Henry Stokes, Alexander MacPherson, Charles Wild, Henry Tryon and Patrick Wall to carry out a variety of museum tasks, including travelling throughout Queensland in search of items of interest to build the State Collection. Henry Hurst wrote to Charles de Vis from the fossil-rich banks of the Condamine River at Chinchilla on the 26 November 1887 reporting that he and Patrick Wall were returning to Brisbane with "*nearly 3,000 specimens*" collected in 70 days and that they had "*nearly worked out this locality*" (Hurst 1887). This letter was typical of frequent correspondence from collectors to de Vis which often included information about their

TABLE 2. Verified sites and localities from the Chinchilla Sand. Abbreviations: QM CMS - Queensland Museum Collection Management System (Vernon).

Site/Locality name *Synonym*	**QML Registration No.**	**Data Source**	**Comments**
Al's Dilemma	QML332	M. Archer field notes (1973-1974)	Chinchilla Rifle Range (Fig. 2).
Barren Gully		C. & D. Wilkinson Collection Register	Chinchilla Rifle Range (Fig. 2).
Chinchilla Sand Type Section locality	QML110, QML296, QML301 QML302 QML309 QML310	J. Woods (Woods, 1960), Alan Bartholomai QM CMS	Chinchilla Rifle Range (Fig. 2).
Col's Knob	QML294, QML307	M. Archer field notes (1973-1974)	Chinchilla Rifle Range (Fig. 2).
Conglomerate Gully		J. Wilkinson, G. Price, J. Louys field notes (2015)	Chinchilla Rifle Range (Fig. 2). Extensive conglomerate layers outcrop at this site.
Euryzygoma Site		J. Wilkinson, G. Price, J. Louys, field notes (2015)	Chinchilla Rifle Range (Fig. 2).
Fence Locality		M. Archer field notes (1973-1974)	Chinchilla Rifle Range (Fig. 1B).
First Gully		C. & D. Wilkinson Collection Register	Chinchilla Rifle Range (Fig. 2). North of circular car park and often the first gully to be explored.
Fox Gully		C. & D. Wilkinson Collection Register	Chinchilla Rifle Range (Fig. 2)
Greahme's Gully *Grey's Gully*		C. & D. Wilkinson Collection Register	Chinchilla Rifle Range (Fig. 2). Named in memory of Cec and Doris Wilkinson's son, Greahme Wilkinson. (Spelling confirmed pers. comm. Cec Wilkinson to JW 14 April 2016)
Intruder's Knob *Intruder's Site*		C. & D. Wilkinson Collection Register	Chinchilla Rifle Range (Fig. 2). Where discarded fossil material from intruders was found by Cec and Doris Wilkinson.
Lion Hill		C. & D. Wilkinson Collection Register	Chinchilla Rifle Range (Fig. 2). Named for its unusual abundance of thylacoleonid fragments in 1990's. (Pers. Com. Cec Wilkinson to JW 23 July 2016)
Liz's Hill	QML295 QML306 QML355	M. Archer field notes (1973-1974)	Chinchilla Rifle Range (Fig. 2).
Lungfish Site		C. & D. Wilkinson Collection Register	Chinchilla Rifle Range (Fig. 2). Lungfish toothplates have been found at this site.
Middle Gully system *Middle Gully Main Gully system Main Gully*	QML2, QML3, QML4, QML5, QML6, QML8, QML111, QML94, QML233, QML234, QML237, QML356	A. Bartholomai QM CMS	Chinchilla Rifle Range (Fig. 2). Both western and eastern gully systems drain into the main gully system which flows into the Condamine River. Alan Bartholomai named the Chinchilla Rifle Range main gully system, Middle Gully system and first published in 1966 (Bartholomai, 1966).

TABLE 2 cont…

Site/Locality name *Synonym*	**QML Registration No.**	**Data Source**	**Comments**
Palorchestes Point		J. Wilkinson, K. Spring field notes (2016)	Chinchilla Rifle Range (Fig. 2).
Pittman's Point	QML331	M. Archer field notes (1973-1974)	Chinchilla Rifle Range (Fig. 2).
River Site *River Shore* *River Terrace*		C. & D. Wilkinson Collection Register	Located on the Condamine River bank 200m downstream of Chinchilla Sand Fmn Type Locality (FIG 1B). (Location confirmed pers. comm. Cec Wilkinson to JW 23 July 2016.)
Sand Scree Locality	QML1, QML95 QML235 QML236, QML354	A. Bartholomai QM CMS	Chinchilla Rifle Range (Fig. 1B).
She-oak Gully		C. & D. Wilkinson Collection Register	Chinchilla Rifle Range (Fig. 2).
Site 1		C. & D. Wilkinson Collection Register and site map	Next to Wilkinson Quarry (Fig. 2).
Wilkinson's Quarry *Dig Site* *Cec & Doris Quarry*		C. & D. Wilkinson Collection Register	Chinchilla Rifle Range (Fig. 2). First published by Mackness et. al. in 2000 (Mackness, Rowe, Muirhead, Wilkinson and Wilkinson, 2000).
Windmill Locality	QML92, QML93, QML297 QML305	M. Archer field notes (1973-1974)	Junction of Windmill Road and the Condamine River (Fig. 1A).

whereabouts, lists of items collected, estimated times of shipments to Brisbane, requests for additional supplies, such as bullets, return train tickets and sometimes salary advances. Information from correspondence and field diaries was transferred to the Collection and Donor Registers when material was accessioned upon return. Kendall Broadbent in particular kept meticulous field diaries, located in the QM Library archives, containing descriptions of local features describing collection sites on the Condamine River and Charleys Creek, but with over 100 years passing these sites are difficult to accurately pinpoint today.

During this phase QM record systems included Collector and Donor Registers using sequential number systems, dates, collector and donor names, addresses, and item descriptions. This was an improvement on earlier data capture, but general locality names like 'Chinchilla' were still common. Fossil material designated by QM collectors in the late 1800s was designated a series of 'C' numbers and many appear in the 'old' Collection Registers as bulk collections. The earliest 'C' number from Chinchilla is 'C14' representing fossils collected by Kendall Broadbent in May 1885 from Chinchilla.

A QM Donor Schedule system introduced in 1911 included an identification sheet, adding more value to the data. An entry on 4 May 1912, recording the donation of the right mandible of a *Nototherium* collected from Chinchilla by Mr Leslie Corrie of Brisbane, shows advancements in identification fields but detailed site information remained lacking.

The establishment of the Chinchilla Rifle Club in 1908 was an important milestone in the history of the fossil collection story of Chinchilla. The club began operations from the original range located west of Chinchilla, most likely near the Golf Club or Rocky Creek area (pers. comm. John Dennis to JW 15 March, 2015), then relocated to the current site, 3 kms east of Chinchilla, around 1912. Today the club

operates as a branch of the SSAA. Scientific collection and research have taken place almost continuously since these early days, so location data for fossils collected from this locality remain broadly accurate.

Phase 2: 1915-1950. The War Years and Depression. This phase was dominated by the effects of the First and Second World Wars and the Great Depression. During this time QM staffing levels were reduced, the museum focused on maintenance, not growth of the collection and while some research continued, there were no funds available for fieldwork, (Mather 1986). Only two donations from Chinchilla were recorded, a *Vombatus* fragment, QMF43548, collected in March 1936 by Mrs C. Bishop providing general locality information 'Chinchilla', and a *Troposodon* jaw fragment with two molars, QMF42631, collected by Mrs A. Bishop with locality recorded as 'Chinchilla SEQ'. Additionally, more than 70 fragments of an individual skull later referred to the giant wombat-like marsupial, *Euryzygoma*, were donated to the QM having been collected from Brigalow, approximately 20 km southeast of Chinchilla. The fossils (QMF1327) were collected at a depth of around 21 m following the sinking of a well on the property of Mr G.A.F. Kleidon. Although Longman (Longman 1921) considered the specimen to be 'Post-Tertiary' (i.e. Quaternary), *Euryzygoma* is reliably known only from Pliocene deposits (Price & Piper 2009) hence the specimen was likely derived from the Chinchilla Sand.

Phase 3: 1951-1970. The Developing Museum. Interest from researchers increased in the 1950s, and this was particularly stimulated by visiting international palaeontologists from the USA such as Ruben A. Stirton in 1954, and Dick Tedford in 1955. Collection data from Stirton's trip is accurate for its time as shown by entry QMF6141, a *Euryzygoma,* collected on 1 January 1954 from Middle Gully system of the Chinchilla Rifle Range by Stirton, Marcus and Woodward. It was during this phase that Jack Woods described the type section of the Chinchilla Sand (formally known as the 'Chinchilla Formation' in Woods 1960) and Alan Bartholomai began his long research association with Chinchilla. As focus on research output increased and more strategic locality designations were required, Alan Bartholomai divided the Geosciences records into two numbering systems, QMF, for fossil information, and QML, for locality information. He established the QML system in 1964 with the first entry, QML1, a site on the banks of the Condamine River at the Chinchilla Rifle Range called Sand Scree. He subsequently regularly used 4-Mile Military maps, topographic maps, and site names to record the position of field sites.

Phase 4: 1971 – 1980. The Bartholomai Years. The significance of fossil material from the Chinchilla Sand became more widely recognised and active collection continued during this phase. Many QM curators journeyed to the Chinchilla area to collect surface fossils from the eroding gullies, mostly from Chinchilla Rifle Range sites. Alan Bartholomai continued his research, joined by QM Curator Michael Archer and a series of trips took place involving the Kelvin Grove Teachers College, who assisted with fieldwork. Kelvin Grove Teachers College lecturer Bernard Cooke, QM Curators Mary Wade, Jenaette Covacovich and Roland Mackay, also collected from the Chinchilla Sand with some minor input from the public. Locality accuracy continued to improve with the use of field maps, locality names, and map referencing using topographic, geological, and military maps.

Phase 5: 1981 – 2000. Casual Collector and Citizen Science - Cec and Doris Wilkinson. Alan Bartholomai was largely focused on his role as Director, but actively encouraged research and field work during this time. Many QM staff and associates assisted with collection and donation of material. This phase was probably more strongly dominated by the involvement of two local Chinchilla residents, Cec and Doris Wilkinson, who collected continuously from the Chinchilla Rifle Range for a period of 31 years, between 1982 and 2013. As well as the typical surface collection they carried out an excavation, recording all fossils excavated in the Wilkinson Collection

Register, which they donated to the QM, along with their extensive fossil collection in a series of donations from 2010 to 2019. This is the only known detailed collecting undertaken at the Chinchilla Rifle Range. Cec and Doris named many of the gullies and developed a local map that has since been used to relocate past collection sites with a high degree of accuracy.

Phase 6: 2000 – 2020. New Technologies. The development of digital technology, and the increase in access to equipment to record spatial data such as GPS, has seen vast improvements in recording accuracy during this phase. Devices like smart phones and satellite navigation units dominate this phase and assisted with verification of survey data for the digital map of the Chinchilla Rifle Range, Middle Gully system (Fig. 2). The map incorporates site and locality names, some basic field geology and the position of the Chinchilla Sand Type Locality and is the benchmark for all future collecting.

Tables 1 and 2 and figure 2 provide a summary of the historic and current data of the key areas considered in this publication. All associated GPS locations and/or map references are lodged with the Queensland Museum Geosciences Program and documented in their Collection Management System (Vernon).

DISCUSSION

Pliocene vertebrate fossils from the Chinchilla Sand have attracted the attention of collectors for 150 years. Multiple collectors over six identified phases have donated fossils and provided location data to the Queensland Museum State and Reserve Collections. The early collectors were pioneers and many deserve recognition for their attempts at recording their work under what would have been difficult conditions, and several museum directors, including Charles de Vis, Heber Longman, Jack Woods and Alan Bartholomai, were key to promoting and encouraging research at Chinchilla. Our review has compared and clarified specific site names and locality number designations for all phases of collecting, resulting in a full list of existing and comparative Chinchilla Sand fossil sites and localities. Several sites in the Chinchilla region, including 'Fairymeadow', Charleys Creek, 'Seven Oaks' and 'Tralee' were not discussed in this study as stratigraphic correlation with the Chinchilla Sand remains to be determined. Through this investigation, QML designations were found to be inconsistently issued and used. For example, in numerous cases QMLs were issued for single collecting events and not used again. While useful in collating and comparing past data, it is not recommended they are used in the future. The digital map of the Chinchilla Rifle Range, Middle Gully system, incorporating updated historical site names and collection localities, provides the first detailed map of the locality.

With the compilation of historical site records and collections from Chinchilla completed, future research can focus on collecting more detailed stratigraphic information on the Chinchilla Sand. Determining the relative chronosequences of these prior sites and the systematic excavation of new collection areas should be a priority. Current work on this front has begun, with the identification of the Chinchilla Rifle Range conglomerate as a potential marker bed. Palaeomagnetic and geochemical dating efforts are already producing promising results that will be important not only at the site level, but at regional and national scales. This work will be incorporated and documented in the Queensland Museum Collection Management System. This research is critical to resolve the degree of time-averaging present in the deposit, and the relative ages of individual specimens or species. As consistent with a best practice approach, all future collections at this site should include detailed recordings of stratigraphic contexts as well as GPS coordinates. At an absolute minimum, this should include the position of fossils relative to the conglomerate bed, where present. This will ensure that the next phase of collecting at Chinchilla will provide a detailed resource for understanding Australian Pliocene ecosystems and their faunas.

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